Slurry Preforming Methods for Automotive Polymer Composites

Glenn A. Moore and Richard W. Johnson
Idaho National Engineering Laboratory
Lockheed Martin Idaho Technologies Company
Idaho Falls, ID

Abstract

A water-based process for the fabrication of chopped fiberglass preforms is being developed by researchers at the Idaho National Engineering Laboratory (INEL) in collaboration with the Automotive Composite Consortium (ACC) and The Budd Company. This slurry process uses hydraulic pressure to form highly compacted chopped fiberglass preforms on contoured, perforated metal screens, Figure 1. The preforms will be used in the development of structural automotive composites. A key objective is to produce preforms having uniform areal density. Computational simulation and optimization tools are being developed to assist in the selection of perforated screen patterns and processing parameters.

For the slurry process to be a viable commercial technology, the process must be understood well enough to allow components to be fabricated in a cost effective manner. A component's geometry and desired areal density variation, the physics of fluid flow through a porous media, and the characteristics of chopped fiber deposition dictate whether or not a given component can be successfully produced using the slurry process. It has been established that a ± 5% variation in areal density is acceptable for 8-16 oz./ft^2 mattes. Given this key constraint and the available range of processing parameters and tooling configurations, we must determine if and how we can produce a candidate component. Thus, knowing the geometry of the candidate component and having a valid computational fluid dynamics (CFD) model that allows simulations over the range of process parameters, we should be able to define parameter settings, hardware configurations, and, if needed, recommend component design modifications. For this task, INEL researchers have chosen FIDAP, a commercial CFD code, for construction of 2-D and 3-D slurry models.

The models depict chopped fiberglass deposition as a porous medium having time-varying flow resistance, Figure 2. There are two primary slurry processing configurations being used at the INEL, a standard flat platen configuration and a 4 in. high "top-hat" ring surrounding the perimeter of the 0-4 in. screen down-step (Figure 3). Experiments are being performed to provide permeability data for input to the model and to validate the simulation results. The goal of this effort is to deliver a user-friendly process simulation tool to the Automotive Composite Consortium (ACC). It is expected that a workstation-based software tool will be integrated into on-going structural automotive composites component design and process development efforts by the Big Three U.S. auto makers and their original equipment manufacturers (OEM) suppliers.

This work is supported by the U.S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, under DOE Idaho Operations Office Contract DE-AC07-94ID13223.